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SUMMARY: HIV infection is exponentially increasing in the past decade among young homosexuals in Japan. Possible influence of social webs among young males whose creation was facilitated by electronic innovation is discussed.

Human immunodeficiency virus (HIV) is transmitted by direct sexual contact between man and woman or between man and man. It is one of the best examples suitable for theoretical thinking of spread of infection through direct contact. First, I present the present trend of HIV infection in Japan (1), and then discuss on the possible relation between its spread and pre-existing webs among young Japanese males.

Fig. 1A and Fig. 1B respectively show the trends of the “HIV-infected” and “AIDS patients” (2) (See Reference 2 for definitions of these two terms). The both figures indicate large increase of HIV-infected Japanese males in recent years. In 2004, there were 680 “HIV-infected” Japanese and 100 “HIV-infected” foreigners. Among “HIV-infected” Japanese, 636 were males and 44 were females. Japanese males occupy 81.5% of the whole “HIV-infected” population. The “HIV-infected” or “AIDS patients” of Japanese females, foreign males and females are increasing gradually but to a lesser extent in comparison with the Japanese males.

There is a large peak of “HIV-infected” foreign females at 1991-1994 (Fig. 1A). Most of them were infected outside of Japan (Fig. 2B). Probably, the peak reflects the particular situation in Japan in early 90’s when many women from Asian countries came to Japan as commercial sex workers. Significant number of them must have been HIV-carriers. The peak is absent in “AIDS patients” (Fig. 1B); women with AIDS symptoms cannot work as sex workers. Interestingly, the peak at early 90’ in Figs. 1A and 2B exactly corresponds the time when the Japanese males infected in Japan started to increase (compare Figs. 2A and 2B).

In 2004, among 636 “HIV-infected” Japanese males, 449 (70.6%) were infected through homosexual route, while only 122 were infected through heterosexual route (remaining 65 were infected through other or unknown routes). Among Japanese males, while heterosexual infection rate appears stabilizing since late 90’s, infection through homosexual route is increasing sharply showing an upward concave curve (Fig. 3). As shown in Fig. 4A, homosexual infection is expanding almost exponentially among Japanese males in age group of 20’s and 30’s. Fig. 4B shows a similar plot for Japanese male “AIDS patients”; the younger group tends to show a sharper increase in the recent 5 years.

Why is HIV-infection through homosexual route increasing so acutely in Japan? To answer this question, we have to look at changes occurring in the society of Japanese younger generations. Importantly, in the last several years, there are increasing incidents caused by “two-shot dials”, “telephone-clubs”, “encounter web sites”, and “legal drug” markets on webs, all related to the development of electronic webs (3). Webs, or link networks, among the young males involved in homosexual activities can be created and be expanding by utilizing such webs. The homosexual activities are in the underground of the society and need networks for expansion. The electronic webs could be efficient mediators. The webs or networks of homosexual HIV transmission are components of other networks, which are again compo-
Fig. 3. The “HIV-infected” or “AIDS patients” of Japanese males classified according to heterosexual or homosexual infections. Reports of infection through other routes, such as intravenous drugs, are small. Abscissa, year; ordinate, number of reports of the year. (A) “HIV-infected” Japanese; HIV-Jpn, total; Male-HI, male total; HomoMale-HI, males infected through homosexual route; HeteroMale-HI, males infected through heterosexual route. (B) Japanese “AIDS patients”: AIDS-Jpn, total; Male-AIDS, male total; HomoMale-AIDS, males infected through homosexual route; HeteroMale-AIDS, males infected through heterosexual route.

Fig. 4. The “HIV-infected” or “AIDS patients” of Japanese males infected through homosexual route classified according to the age groups. Abscissa, year; ordinate, number of reports of the year. (A) The “HIV-infected”: HIVhomo<29, males in 10’s and 20’s; HIVhomo30-39, males in 30’s; HIVhomo40-49, males in 40’s; HIVhomo>50, males in 50’s or older. (B) “AIDS patients”: AIDS<40, males younger than 40; AIDS>40, males in 50’s or older.

ANNEX

Computer modeling of outbreak

Background: An epidemic or a pandemic breaks out often without any prior signs. The SARS epidemic in Asia in 2002-2003 and the avian influenza epidemic in Asia and nearby countries in 2004-2005 are examples. Continued surveillance, epidemiological analysis and preparedness are the basics of the prevention. However, for preparedness, we need to know how infection might spread, and, upon such assessment, we choose the best possible option among different candidate countermeasures and assess the possible outcome. These exercises could be based on the past data of the outbreaks, but our society is continuously changing and the past experience may be inappropriate in some cases.

REFERENCES


Computer modeling: To complement such shortcomings of the experience-based assessment, mathematical modeling is powerful particularly in the present computer era. The computer is suited for assessing the spread of infection, which is non-linear event. Modeling process will give us an opportunity to think over epidemics more theoretically. In addition, results obtained through the computer model may raise new questions that have escaped our conventional epidemiological thinking. For example, computer model may predict in which situations the outcome of an epidemic is predictable and in which situation it is unpredictable.

Link and web: The present mathematical modeling started with the Robert May’s SIR (susceptible, infected and recovery) model. This model best applies to infections, where infected and susceptible individuals encounter randomly. In the real world, however, the people have web of personal...
links. Even for a person, there are different kinds of personal links, such as, frequent direct contact as in work places, less frequent direct contact as in subways or in public places, indirect contact as in sharing the same room, or in sharing a water source that can be contaminated by the shared swage system, etc. (Fig. 1). The infection spreads by utilizing such pre-existing webs. Different pathogens may use different webs for their spread. HIV spreads by direct contact of man and women or of man and man. The webs of links among homosexuals are surely different from those of heterosexuals (Fig. 2).

**Modeling based on consideration of webs:** It is worthy of considering whether mathematical models could be constructed on such webs and to what extent. In such model building, choice of appropriate web types and translating link-intensities into appropriate mathematical parameters are important exercises. As for web types, the frequency distribution of number of links per node (individual person) could be scale-free, normal, Poisson, or else. As for the intensity of link (Fig. 1), how, for example, can infection through water, through food, or through direct contact be ranked in mathematically meaningful manner? Possible interaction with other web(s) will be an important consideration such as in case of HIV infection. The web of homosexual HIV transmission may partially overlap with other webs, such as, those for drugs (Fig. 2).

To some infections, the above consideration may have less relevance. Bio-terrorist attack with anthrax is more like chemical agent attack and the highly transmissible small pox is better assessed by the SIR model. However, for spread of some infections, web structure plays a crucial role and necessitates its consideration.